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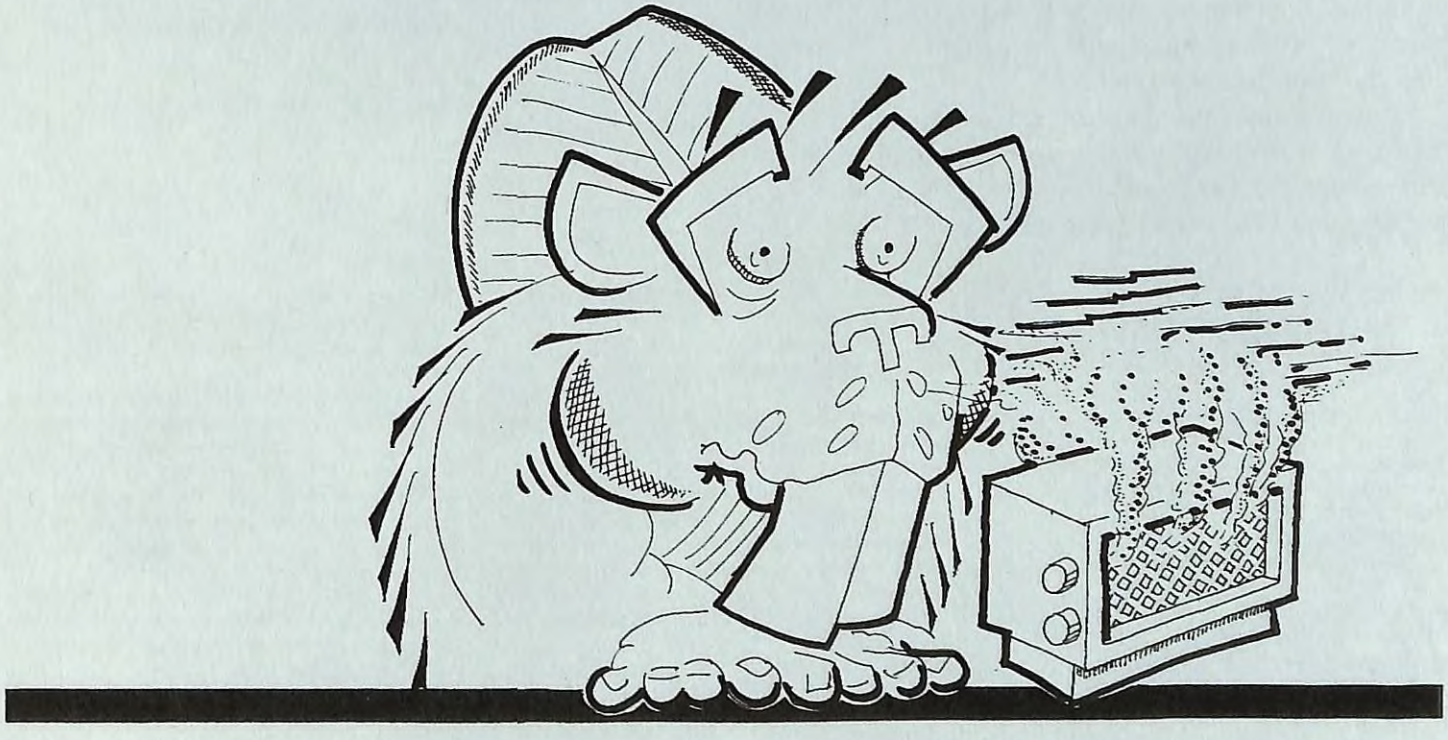
Unvented Combustion Appliances



From the Editor . . .

It's amazing what happens when ideology gets in the way of technology.

The recent Ontario decision to remove the requirement for basement insulation and drainage layer requirements smacks of pure ideology. The step is being taken in the name of "affordability," ignoring the many variables that really make homes affordable - many having nothing to do with construction detailing.

It's no wonder that today's houses are expensive, compared with those in which many of us grew up. After all, they are probably 2 to 3 times the size, with 4 or 5 bathrooms each with expensive fittings, compared with the 1200 sq.ft. bungalow with (at best) 1 ½ baths. Somehow, no one in the industry wants to talk about the impact on affordability of the multiple bathrooms, large storage spaces (expensive warehouse space if you ask me) and many other features loaded into houses today.

At the same time, the operating cost of poorly insulated houses has an impact on affordability, too. If we pay more than lip service to environmental sustainability, then we as an industry should not be fighting tooth and nail against higher standards of construction that will have an impact over the life span of the house. After all, you can change the flooring or the bathroom fixtures anytime after construction, but it's much more difficult to upgrade the insulation or windows after the house has been built.

One can insulate an unfinished basement anytime after the house has been built without excessive trouble, but as increasingly basements are relied on as living space, the underinsulated basements can impose a health (not to mention a comfort) penalty for homeowners. However, the exterior basement drainage layer is something that cannot be retrofitted after the house has been finished.

It's all right to say that "home buyers should have the option of deciding if the foundation drainage layers are right for their home." But what choice does a home buyer really have, unless he's building a custom home and he's sufficiently knowledgeable about all the technical issues? It's not realistic to expect the home buyer or builder to dig up the foundation after construction to install a drainage layer because it wasn't installed in the first place.

We know that home buying decisions are made with relatively little thought or understanding of building technical issues and are largely based on emotional issues, but with the expectation that the construction has been done properly.

Industry seems to be saying "we recognize that it's fair to regulate application of roofing products and siding materials, but leave it at that." But isn't underground water equally important?

The value of the drainage layer has been observed to be not just protection against moisture problems, but also against frost damage.

Shouldn't this merit more serious consideration too?

Richard Kadulski,
Editor

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Unvented Combustion Appliances

You don't light a camp stove or barbecue inside the house. Nor do you light a fire in the middle of your living room, unless that's where the fireplace is found. So why are so many people promoting unvented combustion heating appliances?

Combustion appliances without venting may sound like a ridiculous idea, yet hundreds of thousands of unvented appliances for interior use are sold each year in the United States. Some are even manufactured in Canada. Many US states allow unvented combustion appliances, and others are on the verge of approving them, although the Governor of New York state recently vetoed a proposed approval for that state.

The reason for the big push is that compared with vented heaters, unvented units are generally less expensive to purchase and install. However, there is a growing controversy among concerned individuals questioning the whole idea. Meanwhile manufacturers are aggressively promoting these products although vent-free heating products can only represent a step backward in the safety record of the gas industry.

The material used by manufacturers in their lobbying efforts draws on resources that only a well-funded industry with deep pockets can assemble. As is so often the case, they rely on consulting reports favourable to them. Unvented gas heating products are shown to meet standards only by the selective choice of acceptable pollutant levels and by using assumptions for airtightness of houses that do not reflect the construction practices of the 1990's.

The issue is that unvented appliances dump pollutants into the living space.

We thought it appropriate to highlight this issue because it has become such a big industry, and with Free Trade there will be pressures to market the products in Canada. Currently BC allows unvented appliances in single family detached dwellings, with certain restrictions.

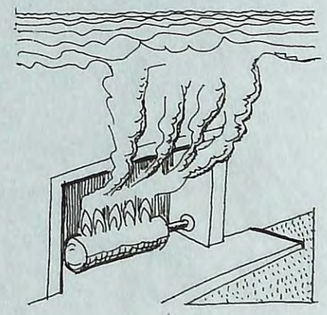
Combustion Venting

Our ancestors long ago learned that you had to remove combustion products from enclosed spaces. Even the most primitive societies at least put holes in the roof of their homes to act as a chimney. Of course, when you burn wood or coal, you can see and smell the combustion by-products, but that is not so with natural gas which burns very clean, giving off primarily moisture.

However, we don't really appreciate the other by products of natural gas combustion and the impact they have on the indoor air quality.

Natural gas combustion produces carbon dioxide (CO_2), carbon monoxide (CO), nitrogen oxides and water vapour, high concentrations of which are detrimental to indoor air quality. These gasses are colourless, odourless, and tasteless so other indications of inadequate air change rates are needed. CO and NO_2 present health risks even at low concentrations.

The primary industry study (conducted by the American Gas Association's Research Division) that is being used to support unvented appliances with claims that vent-free heaters are safe in houses has serious shortcomings It is based on a typical appliance use time of four hours, obtained from a single survey of fireplace users that showed 96% of all owners operate fireplaces for 4 hours or less per use. The suggestion is that persons with vent-free fireplace units are more likely to use their units for decorative purposes rather than principal heating.



Unfortunately a single study of fireplace users does not provide a reliable database for all vent-free appliances. Persons with vent-free heating appliances could and probably will use their units for heating for longer periods. (A cold winter night lasts much longer than 4 hours.)

The predicted pollutant levels are based on mean values of air change rates that don't consider the variation of air exchange rates that result from weather changes (wind and temperature) and use of other appliances. The assumption made was that if there is enough air leakage, it will take care of the combustion products. No mention was made of a "worst case" or even a less than favourable condition. The concern is not "what are the average pollutant levels?" but rather, "what is the probability of damaging levels being developed?" In other words, what is the risk level at extreme operating conditions?

Medical professionals and references were not consulted for the latest research concerning health risks from pollutants. Without uniformly accepted indoor air quality standards, the authors chose acceptable pollutant levels most favourable to their argument, based on their interpretation of "reasonable" levels. Not surprisingly, the higher acceptable levels were chosen.

Gas Combustion By-products

Carbon monoxide

Carbon monoxide (CO) is a product of incomplete combustion. Amounts of CO produced can vary widely. During complete combustion only small amounts of CO are produced, but when there is incomplete combustion large amounts of CO are produced. Incomplete combustion may be a result of inadequate combustion air, dirt or lint on burners, improper gas orifices, and improper gas pressure.

Carbon monoxide is a deadly poison. Even one time exposure to elevated levels can cause permanent health problems. Symptoms of CO exposure at low concentrations in healthy people include headaches, decreased alertness, dizziness, flu-like symptoms, nausea, fatigue, rapid breathing, confusion, disorientation, impaired judgment, and weakness and also decreased learning ability in school children; lower concentrations in people with chronic heart disease include chest pain; and higher concentrations include coma and death. The effects depend on the concentration, duration of the exposure, the individual's activity level and health status and also sensitivity.

The AGA report shows that CO levels can increase from 0 ppm to 8 ppm in only 4 hours of vent-free heater operation in a loose house. Health Canada's indoor exposure guidelines suggest an upper limit of 11 ppm for eight hours, while ASHRAE uses 9 ppm as the maximum allowable exposure for an 8 hour average (not to be exceeded more than once per year). The World Health Organization (WHO) considers CO levels greater than 4.5 ppm to be of concern.

Oxygen depletion sensors required on these units do not protect consumers from all causes of incomplete combustion. The study does not consider the possibility of increased CO production from aging units.

Preliminary results of research still underway suggests that even a regular gas oven without adequate venting can generate high levels of CO. A potentially dangerous example of this kind of application is the gas oven being left open to provide heat. This would also be similar to the operation of an unvented gas log fireplace.

What is the background concentration of CO?

Outdoor CO levels generally are about 1 to 2 ppm (the lower limit of detectability for many measurement methods).

Nitrogen dioxide

Nitrogen dioxide (NO_2) increased from 0 to 0.6 ppm after only 4 hours of vent-free heater operation. This was in a loose house, with 1.0 air change per hour. Health Canada's indoor exposure guidelines suggest an upper limit of 0.25 ppm for short term exposure, while the maximum recommended by ASHRAE is 0.5 ppm on an 8 hour average. World Health Organization suggests the concentration of concern is 0.16 ppm or greater.

Because NO_2 concentrations exceeded 0.5 ppm, the authors of the AGA report model reduced the modeled NO_2 concentrations by adjusting recommended heater input values downward, so they may not create a totally comfortable temperature but will maintain "acceptable indoor air quality." Unfortunately, instruments to detect NO_2 are not or available to most consumers, dealers, installers, or maintenance staff. It is not likely most dealers/installers or homeowners will understand the need to comply with the requirement to downsize the unit.

Carbon dioxide

Carbon dioxide (CO_2) is produced during normal combustion and human respiration. It is not considered to pose immediate health threats but high levels of CO_2 can lead to drowsiness and headache. ASHRAE uses 1,000 ppm as a limit to satisfy comfort (odour) criteria while Health Canada suggests a limit of 3,500 ppm. CO_2 concentrations exceeded 3,500 ppm in less than 2 hours of continuous operation. This was in a loose house with 1.0 air change per hour. All combinations met or exceeded the ASHRAE limit of 1,000 ppm in 4 hours of operation Since a major component of combustion products is carbon dioxide, the rise of CO_2 from vent-free gas heaters is to be expected.

Water vapour

High humidity levels are a concern as they create unhealthy indoor conditions.

Water vapour is released into a house during animal and plant respiration, cooking, bathing, dish washing, and laundry. It enters structures via water leaks and capillary action (primarily through floors and walls in contact with the ground). Excessive moisture leads to deterioration of structural parts of buildings and to wood window frames, which rot. Excessive moisture also leads to mold and mildew growth, increased mite populations, and higher concentrations of bacteria.

Gas combustion generates large qualities of water vapour. Ned Nisson, editor of Energy Design Update, has calculated that a single 12,000 BTU gas cooking burner can easily humidify a home (and also introduce other unneeded by-products). Thus, anything over that contributes to excessive humidity levels.

Adding an additional moisture source to homes already experiencing moisture problems will further degrade indoor air quality. Removing moisture at the source (i.e., the vent-free heating appliance) is the best way to control moisture.

House airtightness

The basis on which the case for unvented combustion appliances has been built is the assumption that houses are leaky. Three different air tightness levels were modeled: loose, average, and tight. The air change rates were 1.0, 0.5 and 0.35 air changes per hour (ACH). The minimum air change rate of 0.35* per hour was chosen because the authors assumed rates below that value would be uncomfortable from moisture and odours and there are both U.S. and Canadian codes that recommend mechanical ventilation below about 0.35 ACH*.

However, minimum recommended air change rates are partly based on moisture and odour considerations. It does not insure occupants living in homes with odour and moisture problems will increase the air exchange rate to 0.35 ACH* or greater. In fact studies have shown people don't always use their mechanical ventilation. Besides, when combustion pollutants are colourless, odourless, and tasteless, other indications of inadequate air change rates are needed.

Consumers expect heating appliances will operate safely over the entire service life. They assume appliances will not pollute air in their home to a level causing them undue health problems. They expect someone (the manufacturer, the dealer, code authorities, the government) is ensuring the safety of the appliance. Although consumer education can be used to reduce risks, manufacturers, dealers, code authorities and government must ensure heating products do not require unreasonable consumer knowledge or present undue health problems. Regulations have to cover those products that present an undue risk.

Consumer education can't be relied on to avoid problems. These kinds of heaters are likely to be used in less than favourable situations, (e.g. low cost housing) where the occupants have limited resources for alternatives, or may not be able to do anything about it.

Vented heating appliances are readily available. They heat economically, without dumping

**This air change rate is the average natural air change, and is not to be confused with that measured by a blower door air test. 0.35 ACH is roughly equivalent to 5-7 ACH at 50 Pascals.*

BC Unvented Heater Regulations

Unvented gas heaters are permitted in British Columbia. The regulations are outlined in the Gas Safety Branch's directive DC 20.

- only one heater per house is allowed,
- they can be only be used for supplemental heat.
- they cannot be used in bedrooms, mobile homes, trailers and recreation vehicles.
- the maximum size allowed is 25,000 BTU (input), and must not be more than 20 BTU per cubic foot of room.
- the unit must be equipped with an oxygen depletion sensor and be labelled that annual servicing is required (this assumes that people read and act on labels!).

combustion products into living quarters. New, direct-vent sealed-combustion gas fireplaces and heating appliances have been designed and are readily available for tight houses. Vent-free heaters represent a step backward in attempts to improve indoor air quality in homes.

Issues that have to be considered when evaluating these appliances include:

Do we want to live in polluted air?

How serious are health problems caused by polluted air and what are the medical costs of breathing polluted air?

What are costs and benefits of vent-free appliances versus vented heaters?

Health Effects of Carbon Monoxide

Why is it we are concerned about carbon monoxide? It is a colourless, odourless toxic gas that is responsible for several deaths in Canada each year. Recently, during a cold winter spell, a number of deaths in Saskatoon were the direct result of CO poisoning - and they happened in middle class housing, not in some low cost, sub-standard housing.

Indoor concentrations of carbon monoxide vary widely depending on sources and occupant patterns of use. Concentrations of 1 to 2 ppm may be found in houses with a normally operating gas furnace, but can reach more than 1,000 ppm in a house with a faulty furnace.

Four burners on a gas stove can cause concentrations of 35 to 120 ppm after 20 minutes of operation (which is why direct venting to the outside is so important).

Kerosene space heaters can produce more than 20 ppm. An unvented gas heater in a 1,150 square foot test house was found to produce almost 90 ppm.

What are the health effects of CO? For the average healthy non-smoker, the health effects of CO are:

200 ppm over 2 to 3 hours: slight headache, fatigue, dizziness, and nausea.

400 ppm (maximum concentration in flue gas recommended by the U.S. EPA and the American Gas Association) over 1 to 2 hours results in frontal headache, and after 3 hours, this exposure is life-threatening.

800 ppm within 45 minutes results in dizziness, nausea, and convulsions; within 2 hours results in unconsciousness; and within 2 to 3 hours results in death.

1,600 ppm within 20 minutes results in headache, dizziness, and nausea; within 1 hour results in death.

3,200 ppm within 5 to 10 minutes results in headache, dizziness, and nausea; within 25 to 30 minutes results in death.

6,400 ppm within 1 to 2 minutes results in headache, dizziness, and nausea; within 10 to 15 minutes results in death.

Building Code changes

Ontario

Ontario Municipal Affairs has released proposed code changes (more than 650 proposed changes). Many proposed changes are substantial, but the stated aim is to harmonize with the National Building Code.

The deadline for comments is December 20, 1996.

Information: Code Development Unit, Housing Development & Buildings Branch, 777 Bay St., 2nd Fl., Toronto, ON M5G 2E5
Tel.: 416-585-666; Fax 416-585-4029

British Columbia

The BC Building Standards Branch is now reviewing the BC Building Code. The proposed update is not based on the 1995 National Building Code, but on the current BC Building Code (this may mean the BC code will increasingly differ from the National Building Code). Information and proposed changes already on file can be viewed on the Internet, at

http://www.marh.gov.bc.ca

The deadline for proposed changes is November 17, 1996, and the deadline for comments and challenges to changes is January 5, 1997.

Information: Building Standards Branch, 747 Fort St., Victoria, B.C. V8W 3E9
Tel.: 250-387-4010; Fax 1-250-356-9019
(note: the new telephone area code comes into effect on October 19)

Engineered Wood Product Information

APA, The Engineered Wood Association has a Professional Associate program. It provides a forum for the exchange of information and ideas for architects, engineers, building officials, builders, and others involved in the use of engineered wood products.

One of the most valuable aspect of this program is that a subscription includes a thick reference binder, containing APA Technical publications. Almost anything you may want to know about engineered wood products - from how the products are made, to technical specifications and application guidelines to research reports, and manufacturer lists is contained in the binder. The material is well organized under category tabs. Regular updates are issued.

For more information
Professional Associate; c/o APA - The Engineered Wood Association;
Box 11700 Tacoma, WA 98411-0700
Tel.: (206) 565-6600
Fax: (206) 565-7265

Heat loss Software

The Heating Ventilating & Cooling Industry Association of BC (HVCI) has developed a heating system design manual in support of a voluntary certification program for mechanical trades. The program was started with the gas utilities in southwestern BC.

The design approach used in the HVCI design manual is a trade friendly method that uses simplified calculations and worksheets. This program is seen as the first step to upgrading the industry - in an industry where for the past few years there has been much questionable work being done.

As part of the design manual enhancement, HVCI has just released a software version of the worksheets. The software was developed by Gary Way, a past President of the BC Chapter of ASHRAE.

The most interesting part of the software package is the room-by-room calculation module.

All plan data can be entered, and the summary sheet will also automatically print out the square footage of areas heated by alternate heat sources and their heat requirements (this is for homes with more than one heat source). The room-by-room input sheets can also be used to calculate the heat loss of a single room, a single floor or the whole house. It only takes 30 to 40 minutes to do a complete room-by-room heat loss on most homes.

If you select a forced warm air furnace with the Appliance Selection Worksheet included in the program, the Heat Loss Summary Sheet printout will include cfm requirements for each room. Other worksheets include a U-value calculation sheet for unusual wall constructions that automatically enters values on the heat loss worksheet.

Mechanical contractors can use the summary sheet for calculating heat loss estimates when bidding jobs. Once the job is secured, the exact room-by-room heat loss for the house can then be calculated.

The software is not stand alone. You need Excel 5 (for Windows). It is in reality a series of macros running in Excel. This means a 386 or better PC is required.

How does this differ from HOT2000? HOT2000 is a more technically rigorous heat loss software, with an emphasis on the building envelope components. It requires much more detailed information, and provides a single building heat loss figure from which heating systems can be sized. On the other hand, the HVCI software is oriented to the hands-on needs of mechanical trades for equipment and duct sizing, and room by room heat loss calculations.

All default values in the spreadsheets are BC building code data and requirements, but they can be customized.

Technical purists will question so much effort going into a method that is not so technically rigorous. However, the approach used has been validated against detailed technical calculations, and the results are within acceptable accuracy limits. It can be considered a computerized rules-of-thumb yardstick.

The software is available for $79 (nonmember price) or $59 (for members).
Information: HVCI, 1860 Grant St. Vancouver, BC V5L 2Y8
Tel/Fax: 604-253-3000

Technical Research Committee News

Canadian Home Builders' Association

Hooking up to the Internet: The Student Connection Program

Still trying to figure out what the internet is all about? You don't have an 8 year old at home to show you? Then this may be for you. The Student Connection Program is a partnership between Industry Canada, the Canadian information technology industry, and post-secondary institutions. It was developed to help small and medium sized Canadian businesses learn to use on-line business services on the Internet.

Introductory level training sessions are provided to show the benefits to be gained through the use of on-line services in solving real day-to-day business issues. These are one-on-one training sessions that last up to two days and may be delivered as a series of separate ½ day modules if required. The cost is $150.

The program recognizes that the knowledge, experience and comfort level with on-line systems will vary considerably. As a result, three program levels are available.

- ***Beginner***: for those who need more time on the basics
- ***Intermediate***: for those with some experience and can spend more time in the business applications elements and less on the basics
- ***Advanced***: for those already reasonably comfortable with on-line services. For these the focus will be on the business applications areas and the introduction to electronic commerce.

The program involves students and post secondary institutions across the country. For information on who to contact in your area, call Industry Canada's Strategic Help Desk at (613) 954-5031 or 1-800-328-6189.

The Technical Research Committee (TRC) is the industry's forum for the exchange of information on research and development in the housing sector.

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Fax: (613) 232-8214

Home Owner Manual

Informed home owners familiar with the equipment and technology in their new home reduce builder call backs. Any appliance or tool you buy comes with a user manual - but homes don't.

Some builders put together a manual that may include product warranties and other information, but it is hit and miss for most home owners. With the assistance of CHBA, CMHC is undertaking the production of a generic user manual that will be available for builders. The idea would be to have user-friendly homeowner's manual that informs and instructs the buyer about the proper operation and maintenance of their house. The intent is to develop a generic document that could be customized by each builder to suit their needs. Work on this is progressing, and is to be completed by mid 1997.

Moisture Problems

Moisture is the root cause of most problems in buildings. As water wets materials, it sets in motion a range of physical, chemical and biological actions that deteriorate buildings. Sometimes, many problems are linked together, at other times each problem has its own issues. Some moisture problems are a result of special local climatic and geological conditions. Others are more universallya result of incorrect construction practices.

Usually, the problems can be avoided if care and attention is given to construction detailing, allowing for natural processes to take place - recognizing that water will appear at certain times and must be allowed to drain off and evaporate. The situation is made more complex with new products and construction techniques that don't perform the same way as more traditional practices do.

Several research activities are now underway trying to establish the cause of the problem, and to develop recommendations that will show how to avoid these problems. One study investigating moisture in wall cavities is looking at Vancouver area projects. Water penetration, in particular with stucco clad buildings, has been a special concern in the Vancouver area in recent years. Several projects, including those that have had problems, and those that have not, are being investigated. It is hoped that this will lead to a best practice manual.

A foundation construction study is underway. It is looking at the whole basement and foundation system.

Carpet Installer Illness

Several cases have been reported about carpet layers becoming ill on the job. Apparently fumes can be so bad that it induces nausea and vomiting. Typically, it is something that has happened during the installation of carpeting. We don't have full details on the circumstances, whether it is adhesives for glue-down installations, or another cause.

If your carpet layers have experienced any health problems, please let Ross Monsour know. We are trying to establish how widespread this problem may be, and initiate further research if it's needed.

Drain Tile Performance

How long does a drain tile work without problems? What parts of the drainage system break down? There is little information on the long term durability of drainage systems. If you've encountered any problems, or noticed any unusual conditions when doing renovations or additions, let the TRC know.

CHBA on the Internet
Visit the CHBA Internet site at:
http://www.chba.ca

The TRC newsletter can be found on this site.

Letter to the Editor

Sir,

We are regular readers of your publication and find it informative. I would like to respond to the article by Bill Walker in your May issue. (Solplan Review No. 68)

I take exception to Mr. Walkers' statement that "the electric rental tank easily outperforms the conventional gas rental tank." He fails to mention that the annual energy cost for the gas water heater is less than half (41%) that of the electric water heater in Thunder Bay and elsewhere in Ontario (36 - 49%). The reason "almost everyone rents gas hot water tanks" in Thunder Bay is because it provides the best value - both rental and energy cost. The statement is based solely on his perception that the vent and fresh air supply to his mechanical room would have a large energy impact. The reality is that the impact is so small that I am not aware of anyone accurately measuring it.

The HRAI Design and Installation Manual for Residential Mechanical Ventilation Systems estimates the flow rate at a design condition of 5 Pascals to be 14 L/s or 30 cfm. This is less than 900 Watts (3000 Btu/hr) on the design day in Thunder Bay (-31°C). If this pressure difference and resulting flow rate existed continuously throughout the winter, I estimate the heating impact to be $33 for the year. Realistically, the average flow rate and cost would be half this figure. Our own field test did not show any measurable difference in energy use in a house with a chimney-vented water heater versus blocking the chimney and using a sidewall-vented water heater. However, this was not a statistically significant field test, only an observation at one home.

I would not want your readers to think that every home requires a five inch hole in the wall to operate a conventional gas water heater - most homes do not. Only chimney vented equipment installed in tightly sealed homes or mechanical rooms require additional considerations for air. For homes like Mr. Walker's, sidewall-vented equipment may be his best choice. There are many types available at much lower cost than the one he chose.

Chris Beuglet, P. Eng.
Senior Engineer, Residential Technology
Centra Gas (Ontario) Inc. and Union Gas Ltd

EcoDesign Search Services

While there is an interest and willingness to use "green" products, product sourcing is not always easy. Anyone involved in the field is inevitably frequently asked "where can I find ...?"

The EcoDesign Resource Centre, a Vancouver based non-profit group, is creating an extensive environmental design and construction library. They have set up a site on the Internet *(http://www.ecodesign.bc.ca)*. They also are available to undertake customized searches for a nominal fee.

For details, contact the EcoDesign Centre.
Tel: 604-689-7622
Fax: 604-689-7016
E-mail: edrs@infoserve.net

Indoor Air Quality in R-2000 Houses

R-2000 Program News

For Information on the R-2000 Program, contact your local program office, or call
1-800-387-2000

The R-2000 Technical Requirements include provisions for using materials with lower chemical emissions. This is done by providing a "pick list" of eleven options, at least two of which must be met.

The low emissions materials requirement was introduced to recognize that indoor air quality relies on the pollutants built into the building. The most effective way of dealing with pollutants is not to introduce them in the first place. Adding ventilation to remove unwanted compounds is not the way to do it efficiently.

Does the use of two or three low emissions materials really improve the indoor air quality? Is it just a token step to highlight the issue? This is a question raised often.

Natural Resources Canada and CMHC have partnered to undertake a thorough study of the issue.

Six R-2000 houses in Ontario have been selected for detailed monitoring. Work is in progress.

An interesting preliminary finding has underlined the impact that residents and their furnishings have on the indoor air quality. In one new house, air quality tests taken after the house was completed, but still vacant, were compared with the tests a short time after the purchasers had moved and settled in. The indoor air quality was much worse, as the new residents not only moved in with their goods, but also undertook substantial interior decoration using products that defeated the intent of the initial materials used in construction.

Greenhouse Gas Emissions Forecast to Continue Increasing

You think that we've turned the corner on greenhouse gas production? Think again!

By the year 2000, emissions in the developing non-OECD countries are expected to pass those of the OECD, largely because of their heavy dependence on coal, especially in the emerging economies. By 2015, world carbon emissions are projected to exceed 1990 levels by 54%.

Continued growth in world oil consumption will drive a 50% increase in world energy demand over the next 20 years. The US Energy Information Administration forecasts that world oil demand will be 99 million barrels per day in 2015 (compared with 69 million today).

In addition, demand for natural gas is expected to grow faster than any other fuel, so the natural gas share of total world energy consumption is expected to increase by 3% to 25% by 2015.

These are the forces that are driving energy efficiency initiatives. If we don't slow the growth of energy use, the recent abberations in weather problems will only increase, and the legacy we leave future generations will be a disaster.

For the building industry, it means greater emphasis has to be placed on improving energy efficiency in both new and existing housing stock. Those in the development sector need to more aggressively pursue planning options that reduce energy use. In other words, the endless suburban sprawl should be reconsidered, and with more emphases on R-2000 level or better standards of construction.

HOT-2000 Software: Demo Version

Demonstration copies of HOT-2000 (version 7.1) can be downloaded from the Internet. This is not a complete package, as you can't print out the results, nor can you save a file. Still, it's a version of the software that allows you to see how the software works. It can be found at:

http://www.greenbuilding.ca/can-sfh.html

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Plywood Standards

Product standards are important yardsticks by which we judge the suitability of specific products for a given application. The situation can get clouded when manufacturers push the limits of allowable tolerances that may affect the product's performance. Unfortunately, the buyer may not be aware of, or familiar enough with the details and is at the mercy of the suppliers.

The issue has been raised again by the Canadian Plywood Association (CanPly), which has a long history of disputes with American plywood manufacturers. CanPly warns that American plywood entering Canada may not meet the quality standards established by Canadian manufacturers. Although stamped as conforming to Canadian Standard CSA 0325.0-92 Construction Sheathing, the American Plywood differs from Canadian COFI EXTERIOR plywood in three important ways:

- American plywood may not be fully EXTERIOR - that is, it may not be accepted for use in conditions fully exposed to the elements.
- American plywood may have defects 50% greater in size than the maximum allowed in Canadian COFI EXTERIOR plywood.
- American plywood may contain defects in the inner plies that require the panel to be retested to ensure conformance to the standard.

It is interesting that no Canadian manufacturers are using CSA 0325 (the performance standard) yet.

CanPly advises that all buyers check the stamp on the plywood to ensure that it contains the following information as stipulated in the National Building Code of Canada:

- the manufacturer of the plywood
- standard to which it is produced
- that the plywood is EXTERIOR type.

Differences exist between the Canadian product standards and the relatively new performance standards. Product standards have been in place since 1978, and cover strength and durability properties, and also requirements for surface solidity or smoothness.

Performance Standards for Construction Sheathing (CAN/CSA 0325.0-92) is an alternative method for acceptance of panels for construction sheathing uses. These were developed in 1988 and are not a replacement for product standards. It covers wood panel products designed and manufactured for protected construction uses such as roof sheathing, wall sheathing, and floorsheathing in light frame construction applications. CSA 0325 does not cover surface solidity or smoothness, does not restrict permitted wood species, and does not qualify panels as exterior type.

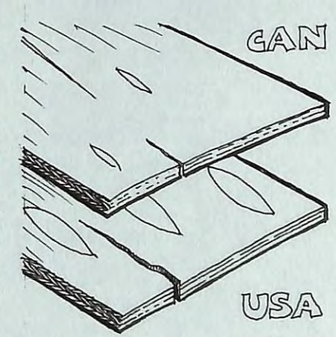
CSA 0325 allows limited use of veneer containing larger defects (up to 3") than the Product Standard limitation of 2". It also requires that binders used in the panels be waterproof and boilproof, but compliance with this Standard does not automatically qualify the panels as exterior type suitable for prolonged or permanent exterior exposure to the elements.

Typical CSA 0325 End Use Designations

Plywood meeting CSA O325 is to be marked according to its use, as follows:

Floor "F" Sheathing: 1F16 or 2F16 "1F" says use for subflooring ("1" says the panel may be used as supplied), "2F" says use for subflooring with panel-type underlay ("2" says something additional is required - ie underlay), and "16" says use with framing members spaced up to 406 mm (16") o.c.

Roof "R" Sheathing: 1R24 or 2R24, where "1R" says use for roof sheathing without edge support ("1" says it may be used as supplied), "2R" use for roof sheathing with edge support ("2" says something additional is required - ie. blocking or H-clips), and "24" says use with framing members spaced up to 610 mm (24") o.c.



There are no specified thicknesses or thickness tolerances in the Performance Standard. Panels of significantly different thicknesses may have the same rating depending on the combination of veneer species, grade and thicknesses used. (e.g. 1F16 panels may range in thickness from 13 to 17 mm).

Noise Isolation

Noise will affect sleep and even daily activity. As urban areas grow and become denser, design for acoustic considerations becomes more important. This becomes more critical as today we use more mechanical equipment and have better amplified entertainment equipment than in the past. Everyone seems to have at least one high power amplifier or boom box (just like every construction site seems to have one set turned up to drown out the heavy equipment noise).

We can forget that what is music to our ears may be a noise to our neighbours.

Acoustic considerations in construction have to deal with noises from two different sources: internally generated noise within the house or building, and exterior noises from the outdoors. Dealing with noise sources generated inside is easier, but exterior sources are there as part of the neighbourhood and one has less control over them.

The degree of noise problems is determined by the context (i.e., you can tolerate more noise at midday in the living area than in the bedroom at night) and the age and lifestyle of the residents. Young party people may have fewer problems than a retired classical music teacher.

Exterior Noise Levels

Controlling exterior noises can be done by design and detailing. How much attention to detail is needed will depend on the general noise levels in the neighbourhood.

<55 dBA Standard construction satisfying Building code requirements should be adequate in all situations.

55 - 60 dBA Window and wall construction satisfying code requirements are normally adequate. Exterior balconies or patios should incorporate solid railings and balcony soffits should be treated with sound absorptive material. Rooms exposed to levels exceeding 55 dBA should be provided with a good ventilation system that will allow windows to remain closed.

65 - 70 dBA At these exposures, extra measures may be required for bedroom windows. Windows with laminated glass should be considered as well as shielding the bedroom windows by putting balconies in front. Exterior walls will likely have to be upgraded on bedrooms by doubling the interior wall board, incorporating resilient channel, adding exterior wallboard, using stucco or some combination of these treatments. Interior ventilation is required.

70 - 75 dBA Extensive measures will be necessary for all constructions and a detailed acoustical evaluation should be performed on any layouts contemplated.

Typical Traffic Noise Levels	
Quiet residential Subdivision	<55 dBA
Residential artery (typical 2 lane road - non truck route)	55 - 60 dBA
Commuter road (4 lane truck route)	65 - 70 dBA
Heavily travelled commuter roads - Most highways	70 - 75+ dBA

Windows

Windows are generally the weakest element of the building envelope for exterior noise transmission. Triple glazing is no more effective acoustically than the equivalent weight in double glazing - it can be worse! Laminated glass is very good at dampening sound, as is triple glazing with a wider uneven spacing. A double glazed window plus a storm window is also effective.

Proper caulking, sealing and gasketing of windows is very important.

Measuring Noise Resistance

Sound transmission characteristics of construction assemblies are identified by their sound transmission classification (STC). These are the listings noted in code and standard documents. However, keeping in mind that these ratings are determined in laboratory tests is important.

Laboratory STC ratings are established under ideal conditions and are generally considered to be the best that the partition can perform. Unfortunately field measurements typically show ratings that are from 3 to 10 decibels below laboratory STC ratings. The smaller differences are noted for the lower STC ratings (simpler partitions) and the bigger differences for higher STC ratings and more complicated constructions - in other words those that are trying to deal with acoustic separation.

What rating is needed to resolve most complaints? Saying what degree of isolation will resolve complaints is not easy because the range of individual reactions to noise is big and background noise levels in homes also vary considerably. Baron Kennedy Lyzun & Assoc., a Vancouver acoustical consulting firm, has observed the ranges at which residents raise concerns. These are summarized in the following table.

FSTC (field measured STC rating)	Rating	
45 to 50	Poor	Complaints can be expected from most occupants
50 to 52	Fair	Many complaints can still be expected
52 to 55	Good	Most occupants will find noise isolation acceptable, but the odd complaint may still be made
55 to 60	Superior	Most occupants will consider isolation acceptable (empty nesters in high price range may still raise complaint)

While many of these details are especially of concern in multi-family buildings, they are becoming a concern in single family dwellings, as so many are incorporating a secondary (or in-law suite), or even just to isolate a home theatre from the rest of the house.

Design Conflicts

Hard floor surfaces over sensitive rooms (e.g., living area over a bedroom) should be avoided by the design as there is no easy solution to this problem at present.

Kitchens next to bedrooms can be a problem, and should be avoided. Resolving the problem by redesigning the party wall is possible.

Shear bracing walls can be a problem. Nothing must be placed in the gap between the studs in double stud walls. This can be a structural conflict. Putting shear bracing on the outside face of the studs is better.

Ventilation and plumbing noise are a significant problem in multi-family construction and are becoming as an issue in single family dwellings.

Mechanical Noise Concerns

Heat pumps may need a special room to isolate noise. Verify, by asking supplier for noise data.

Multi-speed fans on some equipment can be noisy and noise levels can vary.

Vibration isolation is needed for the equipment and ducts or pipes.

Airborne noise isolation in ducted systems can be achieved by fully ducting supply and return air flows, and using some duct liners. (However, duct liners should not be used extensively as they can become a collection and growth medium for microbes).

Location of mechanical equipment should not be next to bedrooms.

Vent chases in walls or ceilings can be noisy.

Flanking noise through ducts - where a duct layout allows sound transmission from one room to go the next room.

Developer Beware:
Don't over sell a project. It is not possible to provide a home or multi-family project that is "Sound Proof," "No Noise," "Quiet Living," or "Inaudible." Sales people must be reminded not to make unrealistic claims.

Details Which Give Good Airborne Noise Isolation

Walls

The typical interior wall in a house (drywall either side of wood studs) usually provides an STC of 35. Double wood or metal channel studs, with one or more layers of drywall on each side, and batt insulation in one or both cavities, will achieve an STC of about 52.

Floors

1½" or thicker normal weight concrete on 2 x 10 joists or similar truss joists, batt insulation in the joist cavities, one or more layers of drywall on resilient channel. A better floor would have a suspended or dropped ceiling joist.

What doesn't work for acoustic separation:

- Interior wood sheet shear bracing in walls
- Vents or plumbing in party walls
- Poor field inspections
- Hard floor surfaces
- Wall mounted speakers

Plumbing Noise Guidelines

- Review riser & waste stack locations to reduce disturbance.
- Use cast iron throughout the waste system.
- Avoid running plumbing services in party walls.
- Vibration-isolate supply and waste lines.
- Vibration-isolate toilets.
- Select quiet fittings where possible (i.e., quiet toilets, quiet taps, etc.)

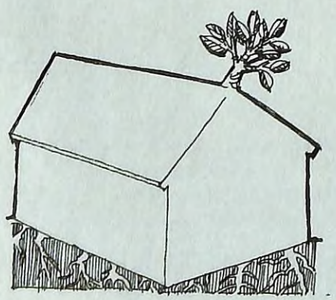
Resource Efficient, "Green" Building

Green construction; ecological design; environment friendly; sustainable construction. You've heard these phrases, and many more, but what do they really mean? What impact do they have on the job site?

Environmental concerns are not just the whims of tree huggers or power hungry bureaucrats trying to dream up more red tape; they are real problems we are becoming aware of just now. Rather than approaching the issue with fear, we should consider the positive aspect: better quality. Environmentally sustainable buildings are better in many ways, from indoor air quality and energy efficiency to greater durability.

A key fundamental of "green" construction is an analysis of materials and systems used in a building. To be environmentally responsible, it is not a matter of replacing one material for another. Just as we've come to understand that a "house is a system," greater than the sum of the parts used to build it, looking more carefully into the background of the materials we use is necessary. This is because the extraction, manufacture, packaging and shipping of products always entail environmental impacts. Some may be more harmful than others, depending on the nature of the raw material, the kind of processing needed, the energy input to produce the product, the recyclability of the materials, etc. There is no doubt that environmentally sensitive construction requires more care and attention, especially if you are making this a special feature for the first time.

Rating systems are only starting to be defined, so that in the future identifying products that meet specific environmental targets will be easier. In the meantime, you have to do your own homework. In general, the key points to look for when assessing a product for its "greenness" include:



- does this product entail much energy to manufacture and install?
- is this product resource efficient?
- Is it durable?
- is this product recycled, and recyclable?
- is this product stable, not contributing to indoor air quality problems?

The Advanced Houses program highlighted the application of new products and techniques for new construction. The same concerns for energy efficiency and for materials that do not contribute to indoor air pollution are important to green construction.

In The Great Canadian Reno Demo Project we set out to show that new products and technologies that are environmentally responsible can be used even when renovating an existing house. All materials used are currently available.

Perhaps the greatest innovation in terms of standard construction was the use of prefabricated stressed skin panels for the addition. Stressed skin panels are not new, but they are not often used. Although not standard construction elements, they are accepted by code (the manufacturers provide necessary engineering papers). Rather than conventional framing, the panels are factory manufactured elements that consist of oriented strand board skins over a rigid polystyrene insulation core. As there are no studs to provide thermal bridging, the overall insulation value is much higher (the 4 1/2" thick panels provide an R 28 wall). The structure, insulation, air and vapour barrier installed in one step, using considerably fewer framing materials.

In the past, basements were left unfinished and uninsulated. However, they are a major source of heat loss, especially as most people make use of the basement as living space. Insulated foundation form systems, a recent development, trade off cost against better performance, reduced labour costs to form and strip, and less material waste as the formwork and insulation are installed in a single step.

Windows typically are the greatest single source of heat loss in a house. Fortunately, this is one area that has changed much in the past few years. High performance windows are now widely available, although they still may be used only in custom homes and renovations.

Interior finishes have to be chosen with care, particularly if indoor air quality issues are being considered. Here, the selection of materials can be made with the help of that high quality, precision instrument we all have but seldom use - our nose. If you can smell it, it probably will be a problem. There should be no reason the people on the jobsite should be getting high (and scrambling their brains) on the fumes.

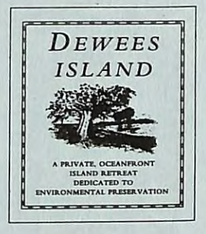
Liquid coatings and adhesives used for interior finishing should be water-based products. These generally have low emissions of volatile organic compounds (VOC's). There is a wide range of such products available today, many with Ecologo certification.

Floors may be more of a challenge. Hardwood and ceramic tiles provide a clean and durable finish, but often at a premium price. Most cushion flooring contains various plasticisers that represent a source of VOC contaminants. Low emission carpets are now available, but from the point of indoor air quality they are a concern simply because keeping them free of dust and microbial contaminants is impossible, no matter how good the housekeeper. In addition they have a relatively short lifespan, so they will be replaced several times over the life of the building. As yet, there is little recycling of used carpets taking place.

The challenge in environmentally sensitive construction is being open to new products and ways of building. Some of these may in fact be simpler. The other challenge, of course, is sourcing suitable materials. Not all are available at the usual suppliers although the situation is changing very quickly.

We are not going to see legislation requiring "green" construction, but product and equipment standards are changing to give more weight to environmental issues. Waste management is one area that will have more impact on the job site, and it can mean lower costs.

Dewees Island
A case study of an environmentally sensitive development.



This is a 150 home island development near Charleston, South Carolina, targeted to high income, environmentally sensitive clients. There will be no golf course on the island, no paved roads (just crushed limestone), no automobiles, and there are very stringent design and materials guidelines. In addition a covenant protects more than 65% of the island as a nature conservancy and that area will have no development on it.

The philosophy underlying Dewees is that people are an essential participant in the environment. People simply need to rediscover how to live in harmony with the environment and re-learn how to select habitat and nest within it (as opposed to dominating and destroying more than is needed).

The underlying principles of Dewees are that:

- development and environment are natural allies
- all development & building should occur in the context that all resources are limited
- communities and buildings can be resource providers, not just resource users
- land use is a stewardship role for future generations
- building in harmony with the environment is less expensive in the short and long term
- communities are planned for people and technologies are to be supportive not dominant
- environmental education is an essential "first step" in the rediscovery of our intuitive sense of integrating with the environment.

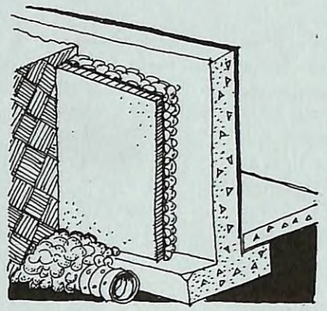
The project has received much interest. Although it is a high end project, which provides some room to experiment and break new ground, it does point out the way that environmentally sensitive development can be done. It also shows that people are willing to pay a premium for a quality environment.

Green Building Rebates

So you think some green construction ideas are strictly for the birds? Just consider this: in some areas of Germany, a subsidy of 40 DM ($40) per square meter is paid owners for sod roofs. The object is to provide greater vegetation cover, reducing the hard surface cover.

Earth shelter construction (or just sod roofs) provides a larger vegetation cover, decreasing the impact of a building on the environment. It reduces overheating in the summer, and moderates winter conditions seen by the house, and also acts as a carbon dioxide sink.

Foundation Water Problems



Today basements are increasingly being used as finished living spaces. They no longer are just unfinished cellar spaces. To meet the needs of today's more demanding home buyers, basements must perform to a higher standard of quality. But basements have long been a source of problems for home builders.

According to historical data collected by the Ontario New Home Warranty Program, 21% of all basements have been built with significant defects. The situation is probably not much different in other areas.

Leaks occur through cracks that are the result of poor or inappropriate construction practices. Foundation walls are typically constructed with concrete. They are also subjected to ground movement due to shrinkage, swelling and settlement of the surrounding soils, which causes pressure that contribute to cracking.

The most common basement defects relate to leaks and dampness. To deal with these problems, major changes to basement construction requirements were included in the 1993 changes to the Ontario Building Code (OBC). These called for a drainage layer on the exterior of foundation walls. Since that time, evidence indicates that basement leakage problems have declined dramatically.

The main way to avoid moisture problems is to keep the water away from the foundation.

Dampproofing does not waterproof a basement; the dampproofing only seals the small pores in the concrete to reduce capillary action into the wall. You may think that applying a "waterproofing" membrane will do the job. On the surface, this sounds logical. The reality is not so simple. A membrane applied to the exterior of a basement wall to resist water is subject to damage, and the smallest puncture can expand over time. Waterproofing treatments applied to the surface of the concrete just can't be assumed to be perfectly safe in the long term.

The 1993 OBC required a basement wall drainage layer that can be mineral fibre insulation, free draining granular material, or a system which can be shown to provide equivalent performance to either of these two materials. The requirement was for a minimum 19 mm (¾") mineral fibre insulation; at least 100 mm (4") free-draining granular material; or an air gap membrane. Since the introduction of the drainage layer requirement, a range of new products has been developed.

The principle is that if the water can't get at the basement wall, it won't be a problem. Ground water finds the path of least resistance so that the relatively large voids created by the drainage layer, be it gravel, membrane or rigid mineral fibre board, becomes the preferred path for the water so it will flow down to the perimeter drain tile system, rather than press against the foundation wall.

In most cases, it doesn't matter if the drainage layer system is applied perfectly or not (unlike a waterproofing membrane that has to be perfect at all times).

Manufacturers' instructions must be followed to ensure all areas of the wall are adequately protected. Air gap membranes, such as the Platon system or the various geotextiles are very effective because they create larger gaps in the backfill against the basement wall, thus reducing the water that gets at the basement wall.

Unfortunately, the Ontario Building Code has been changed to delete the requirements for basement wall drainage. We wonder what has changed in the way basements are built in Ontario today that basement leakage is no longer a problem? Or is it a case of deregulating for the sake of deregulation?

Design and Construction Issues

The entry of water through basement leaks can happen when water around the foundation is accompanied by any of the following:

- poor surface drainage
- poor quality backfill
- lack of a drainage layer
- improperly sealed tie rod holes
- wall cracks (weak concrete or excessive honeycombing)
- clogged perimeter drains
- improper dampproofing and/or moisture barrier

Solutions

Avoiding leaks requires detailing and construction that directs water away from the foundation and ensures adequate subgrade drainage. In other words: minimize the leakage potential. This is why the use of either free-draining granular material, approved free-draining rigid insulation, an air gap membrane, or composite geotextile (used in commercial construction) on the outside face of the wall can be so effective. It creates an easy path for ground water, so rather than hitting the wall, the drainage layer removes the water, and the foundation wall does not face the hydrostatic pressure.

But foundation drainage layers by themselves will not do their intended work unless additional simple, effective and economical measures are taken. These measures, which constitute good engineering practice, include:

- provide an impervious topping-off layer of clay-silt mixture on top of the backfill with a positive slope leading surface water away from the building
- create a well-defined drainage path for the water to enter the footing drain
- provide a footing drain (weeping tile) adjacent to the footing at the base of the foundation to channel water to the storm sewer. This drain should be embedded in a 150-mm layer of gravel or crushed stone.

Moisture in Materials

Another source of basement moisture problems is due to moisture in materials during construction - from moisture in concrete, lumber and finishing materials. In most cases, once the construction has had an opportunity to dry out, the amount of moisture left is not significant unless more moisture is added, as can happen when there is a leak.

Although it is important to prevent ground moisture from getting into the wall assembly, it is also important to allow moisture to exit out of the wall and allow drying. Periodic wetting may be unavoidable and it may not be a problem as long as it is temporary and drying can occur.

Just as in above grade construction, a good air barrier is important in the basement to minimize air leakage.

Basement Air Leakage

Air leakage needs two elements: an air leakage path and a driving force. Exhaust fans and the natural stack action (the tendency for heated indoor air to rise up and out of the building) will allow cold air to leak inward through the lowest areas in the house - generally around the basement area. These are also areas that, in the right circumstances, will allow water in. The areas to look for air leakage are:

- foundation wall and floor cracks
- perimeter of floor slab
- floor drains and sump pits
- basement window frames
- header area (sill plates and anchor bolts)
- electrical outlets
- wall penetrations for service connections and ducts

Moisture Control Checklist

- ☑ Perimeter drain bed sloped to outflow
- ☑ Dampproofing placed on wall to 150 mm (6") above grade
- ☑ Drainage material continuous to perimeter drain
- ☑ Finished grade sloped 5% away from building
- ☑ Delay application of finishes to maximize drying
- ☑ Drainage layer top edge flashed/sealed

Build It Right the First Time *Better Basements: Construction Practice Booklet is published by Ontario New Home Warranty Program. It contains a number of suggested details for a variety of construction systems. Publication Toll free number: 1-800-668-7504*

Good basement drainage details offer another benefit: in winter they can reduce foundation frost problems. Effectively, the drainage layers provide a slip plane for the frost.

SECOND PRINTING

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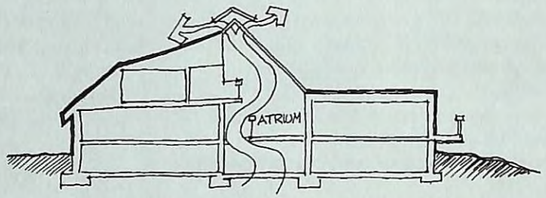
Atrium Spaces: Do They work?

by Terry Lyster



Do atrium spaces really work? With all that skylight area, don't they overheat in summer?

A glazed atrium in the recently completed WindSong CoHousing project in Langley, B.C. provides an example of how such a tempered environment between dwellings works.

The 34 unit project is based on housing models developed in Scandinavia and the Netherlands. It occupies a 5.8 acre site at a single family density, but the dwellings are clustered along a central pedestrian spine with amenities and shared facilities at the centre. Parking is underground.

Because of the compact building form, about 4 acres of the site are preserved in their natural state. (Frequent readers of Solplan Review will appreciate that a family of beavers shares the site with the WingSongers).

Emphases on pedestrian connections between units evolved into an "all-weather" cover for the pedestrian spine. The atrium creates an interesting semi-public space that acts like a Mediterranean village street. It expands the space available to residents, offers opportunities for informal socializing and is great place for kids on a rainy day.

The design of the covered atrium evolved during the planning stages. Concerns about over heating and ventilation initially led to some "high-tech" design involving mechanical vents, temperature sensors, massive air-handling and enormous expense. After cost estimates were prepared, a passive (or "low-tech") design was developed.

The main portion of the atrium glazing faces the rising sun and uses the shadow of the dwelling units to reduce heat gain after abut 10:00 a.m.. A fixed vent runs along the peak of the structure. This opening makes the space an "open space" for Building Code purposes while shielding the interior from precipitation. Air is admitted to the atrium through the lowest level of complex by manual operation of windows.

During a prolonged heat wave in the first summer of operation the atrium worked efficiently as a passive "air-conditioner." The first winter will complete the "shake down" period.

The project was conceived by a core group of families and helped by Northmark Projects, an adventurous developer interested in expanding the vocabulary of housing types. WindSong is documented in the recent book ***The Cohousing Handbook, Building a Place for Community*** by Chris Hanson ($29.95 published by Hartley & Marks).

Terry Lyster provides illustrations for Solplan Review and was the Project Manager for the development phase of WindSong.

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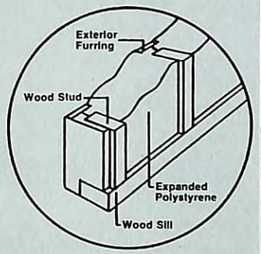

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